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Introduction

The word 'identification' originates from the Latin '*idem*' meaning 'the same' or 'identical'. Therefore to confirm that an 'identification' has been achieved, regardless of whether the individual is alive or dead, requires that two sets of directly comparable data be brought together for the purposes of agreeing an identical match. In reality however, such a match can rarely be achieved as all means of assessing markers of identity carry inherent practical error and most biometrics change with time as the human is a biological structure that does not remain constant (Ratha *et al*. 2003, Jain *et al. 2004)*. Further, the forensic requirement imposes an extrinsic minimum level of concordance between the two data sets to satisfy the judicial authority that a match has likely been achieved (Robertson and Vignaux 1995, Dessimoz and Champod 2008, Bouchrika *et al*. 2011, Ferguson and Raitt 2013). Therefore confirmation of forensic identification is predicated on the strength of a match between two comparable but not necessarily identical sets of data, to a standard that is deemed acceptable to a judicial authority.

It is extremely important for all concerned to understand that there is unavoidable inherent error associated with forensic identification and that it is important to establish how much error can be tolerated to ensure that the correct identity has been attributed to the right individual (Lucy 2005, AFSP 2009, Aitken *et al*. 2010). For this reason,

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confirmation of identity is rarely a rapid process as it requires that all avenues be explored to ensure that the degree of certainty in a match is maximised requiring that every inconsistency be scrutinised to determine whether the error associated with it, can be tolerated (Black *et al*. 2010). This can be extremely difficult for families and friends to understand when what they want more than anything is a swift answer and the remains of their loved ones returned to them expeditiously (Jensen 2000, PAHO 2006). But misidentification is to be avoided at all costs because it is not a single event, it exhibits multiplicity. If one person is assigned to the wrong identity then it has also been denied to the correct person who should own it and so in a misidentification there are at least two mistakes made (Mundorff *et al*. 2008). Therefore a forensic identification needs time to ensure that all necessary avenues are explored, that all inconsistencies can be explained and tolerated and that the inherent error is at an acceptable level for all concerned (Turney 2010).

The similarity between the processes of identification regardless of whether the individual is alive or dead, is evident in the recording mechanisms operated by INTERPOL (Black *et al.* 2010, INTERPOL n.d.). When a person is notified as missing, INTERPOL's General Secretariat, at the request of a National Central Bureaus (NCBs) in one of its 192 member countries, will distribute what is known as a 'yellow notice' and this same form is completed whether the individual is thought to be alive or dead. When an unidentified dead body is found, a 'black notice' is distributed with the anticipation that a yellow notice may be found that will be sufficiently close in content to the black notice to facilitate further investigation with regards to a possible match. In disaster victim identification (see chapter 21) ante-mortem information is collected on

the yellow recording form (comparable to the missing persons form) and post-mortem information is recorded on pink forms (comparable to those generated from a black notice). Therefore, there is an inherent understanding that identity is not something that is lost with death and the means by which scientists are able to establish a close link between indicators of identity is robust regardless of whether the missing person is alive or deceased (PAHO 2006).

Primary Methods of Identification

INTERPOL ranks its identifiers as being either primary or secondary in nature (INTERPOL 2009). Primary identifiers are those which may be accepted in isolation as reliable indicators of identity with a high probability of securing a match. Secondary identifiers carry more likelihood of error and, to reach an accepted level of agreement that identification has most likely been achieved, may require that several of these identifiers are utilised. In this chapter we will concentrate on the primary identifiers and will mention only briefly some of the secondary identifiers that may be of greatest value. We will then conclude this chapter with a case study that remains unidentified at the time of publication to illustrate the utilisation of primary and secondary identifiers.

INTERPOL recognises three primary indicators of identity – DNA, fingerprints and dental information (INTERPOL 2009). Although it is unquestionably true that confirmation of identity is more secure the greater the number of indicators that are in concordance, any one of these three may be utilised in the absence of any other indicator, but obviously it cannot be contrary to other accepted indicators. It is the duty of the legal authority to ensure that the probability of a correct identification is as high as it is possible to achieve. Only then will there be sufficient confidence in the decision

making required to permit legal notification and subsequent release of the body for funereal purposes.

DNA, the molecular barcode of life, is present in virtually every cell in the body in one of two forms – either as nuclear DNA or as mitochondrial DNA. Nuclear DNA is a product of half the genetic component from the person's father and half from their mother whereas mitochondrial DNA is only passed down from the maternal source although recent changes in UK legislation challenge this bold statement (Collins 2012). It is generally accepted that mitochondrial DNA possesses a preferential survival rate compared to nuclear DNA and this is important when identification is being attempted from remains which are badly decomposed, burned or fragmented (Foran 2006). It is well known that DNA can now be extracted from extremely small samples but it is important to know which site will give the optimal chance of good recovery and equally how and where to collect ante-mortem or familial DNA for the purposes of comparison. It is equally important to ensure that the quality of the ante-mortem DNA is secured as there is no value in concentrating on quality or quantity on only one side of the identification equation as they are utterly co-dependent. There is no doubt that DNA that can be sourced directly from the missing person is preferred, i.e. direct profile matching. This may necessitate sampling from sources including tooth brushes, razors, brushes, combs, hats, underwear and dental appliances where it is known that the missing person's DNA is most likely to be located (Montelius and Lindblom 2012). To avoid erroneous DNA mixtures, the expert has to ensure that the items can only have been used by the missing person and cross checking between these different sources will ensure that a robust profile is secured. In the absence of such information, perhaps

because of the passage of time in securing confirmed sources of the victim's DNA, then familial DNA can be substituted but this will not confirm the identity of the deceased with the same degree of reliability as will direct match profiling (Ge *et al*. 2011). Familial DNA will confirm only the familial relationship of the individual to the DNA donors. The closer the relationship to the missing person, then the more confident will be the potential match. Therefore parents, siblings and offspring are the primary target sources, with more distant relations being of lesser confirmatory value.

Ante-mortem DNA will be collected by a trained forensic practitioner and stored so that it can be compared with all samples recovered from the mortuary. The source of the DNA recovered from the mortuary will be dependent on the state of preservation of the remains. Often samples of muscle tissue are sufficient if the body is relatively recent but if decomposition is advanced then it may be necessary to take samples of bone or tooth (Collins *et al*. 2002). These too may prove to be of limited value if the body is perhaps burned or fragmented and environmental factors such as heat, humidity or a salt water environment are detrimental to the survival of DNA. The more fragmented and denatured the DNA samples then the greater the difficulty in obtaining a full profile and consequently there is a reduction in the strength of match for identification and this may be further compounded if only familial DNA is available for comparison.

Confirmation of identification through DNA analysis is generally the preferred route and the one that carries the greatest degree of assurance but fragmented or denatured DNA from the deceased, no match to a DNA database and no match to a known missing

person, means that this route may not provide the desired outcome of being able to ultimately ascribe a name to the deceased.

Fingerprints are the next most favoured approach to determining identity but this biometric also faces the same issues as listed above for DNA in terms of likelihood of a successful outcome (Maltoni *et al*. 2005). Although fingerprints are generally identified as the preferred latent print, other prints may also be considered and these include palm prints, foot prints, toe prints and less commonly used ear prints and lip prints (Champod *et al*. 2004). Although until relatively recently, fingerprints were placed within the same category of strength of evidence as DNA this has changed with the outcome of the Shirley McKie investigation (McKie and Wallace 2007, Cole 2008). Ante-mortem fingerprints may be difficult to find if the person is not already on a database and so successful location and retrieval will again require the involvement of a trained forensic expert. Prints may be lifted for example from windows, computer screens, books, electronic readers, mobile phones, door handles, drinking glasses, photographs in frames etc. The ingenuity and experience of the scene of crime officer is invaluable in this regard as unlike DNA analysis, there is no familial substitute that can assist.

As with DNA, the ability to recover fingerprints in the mortuary will also be dependent on the condition of the body and the degree of advanced decomposition. Skin slippage can occur relatively soon after death and if the sloughed epidermal glove is retained then a print can be retrieved (Robb 1999). However, if it is lost then a dermal print is possible but this will not match perfectly to an epidermal print which will be the basis for the ante mortem comparison (Champod *et al*. 2004). Following the Asian tsunami

of 2004, fingerprints proved to be of greater assistance for countries who issued biometric identification cards to their citizens which meant that they had a centralised fingerprint database.

Teeth survive decomposition well and are frequently preserved even after long-term exposure to soil conditions and immersion. Resistance of the dentition against excessive heat and fragmentation is due to the high inorganic content of teeth and the relative protection afforded by the soft tissues of the mouth. The human dentition has been regarded as highly individualistic especially when there has been odontological intervention. It has been said that over 2.5 billion different possibilities exist for charting the human dentition, based on the combinations of missing teeth, filling materials, lesions and prostheses involving the total number of 160 dental surfaces (Frearnead 1961, Heras *et al*. 2005*)*. Any restorative work or dental intervention undertaken can result in an ante-mortem record that is invaluable for comparison purposes with the deceased. Under these circumstances it is vital for there to be a known missing person to match with the deceased as there are no general dental records kept as a searchable database in most countries. In the Asian tsunami of 2004 dental identification proved to be the most reliable means of confirming identity for western citizens as decomposition severely impacted on the ability to extract viable fingerprints or DNA profiles (Petju *et al*. 2007, Schuller-Gotzburg and Suchanek 2007).

Secondary Methods of Identification

When a deceased is found and none of the three primary identifiers described prove to be of assistance for the purposes of identification, then forensic investigators must rely on what are called secondary source identifiers. Those may include personal effects

(jewellery, clothing, documents etc.), medical matters (scars, diseases, trauma etc.), body modifications (tattoos, piercings etc.), photographs and descriptive appearances of the individual (Black *et al*. 2010). These indicators of identity do not carry sufficient individualisation power to be utilised in isolation but when considered in combination, they may cumulatively pass a threshold whereby identification may be confirmed. A case study is included at the end of this chapter which, at the time of publication, has not resulted in confirmation of an identity but illustrates how primary sources did not assist and how secondary sources have been utilised.

Secondary identifiers are features which are unlikely to be unique to the individual but which still have some discriminatory capacity. For example, body modifications are increasingly popular as a form of self adornment and most commonly represented by tattoos and piercings (Black and Thompson 2007). INTERPOL forms permit recording of these alterations to the body and whilst family and friends may be able to recall those which are visible for example a tattoo on forearm or pierced ear lobes, more intimate partners may be able to provide information on modifications that are not visible such as nipple piercings and tattoos in more private regions. In terms of tattoos, some are particularly individuating as they may include a specific date or name but the majority are freely reproduced and rarely unique. However where the tattoo is chosen to be located, its size and colour as well as its pattern are all selected by the individual and so therefore there is a strong element of individuation especially if there is a multiplicity of modifications. Piercings tend to be less identifiable as there are limited suitable places on the body for mainstream piercings and so unless the jewellery used is unique or the location is unusual, this modification can be of restricted value for identification.

Modifications that are not main stream, but are considered to be extreme, have a greater value for discrimination simply because they are less common (Benecke 1999). Often those who go to extremes of body alteration are more extrovert and photographs may be available that would allow comparison of the location, number and type of modification. These may include elective amputation, tongue splitting, penile beading, corsetry, rib removal and many other alterations that are limited only by imagination. There is little or no regulation in the tattooing, piercing and implanting industry and so therefore no recourse to a database to aid comparison. Therefore if this is to be a successful means of identification it requires careful and accurate data collection both from the ante-mortem and the post-mortem sources.

Personal effects may be of value but, as a transferrable commodity and frequently not being unique, they can never be considered to be more than of assistance in identification (Puxley and Thompson 2007). Clothing, jewellery, electronic devices, luggage, documents etc. may give the necessary clues to permit identification teams to track down a missing person which will permit further investigation through primary sources of identification and therefore they have a strong role to play in intelligence gathering perhaps more than in the process of identification *per se*. The item may be readily linked to a named person but linking the named person to the deceased still requires robust biometric support.

A ‘unique medical condition’ refers to situations in which foreign devices, perhaps bearing a serial identification number, are implanted within the human body. These

may be for example breast implants, a pacemaker or a hip prosthesis but providing they carry a unique reference number (URN) then they may be matched to known medical records associated with the individual (Clarkson and Schaefer 2007). Unfortunately, not all surgical facilities will record the serial number of the implant and without prior intelligence on the possible identity of the deceased, then this feature will likely prove to be of limited value as no central records or databases are commonly kept that would support random searching.

Finally, when all else has been addressed, then the value of the face may be considered (Wilkinson and Rynn 2012). It has been shown in previous mass fatality events that facial identification is inherently flawed as a process of matching ante-mortem and post-mortem information with the circumstances of the death often rendering environmental insults too detrimental to support an objective analysis. Ten percent of victims of the Asian Tsunami and fifty percent of victims of the Bali bombing of 12 October 2002 were wrongly identified by facial recognition (Lain *et al.* 2003). The family member, who is asked to look at the faces of the deceased to find their loved one, is not a reliable source of identification. They have never seen their family member dead before, they will be severely distressed, they may be desperate for closure and despite best intentions, past experience has taught that mistakes will be made (PAHO 2006). Therefore INTERPOL does not advocate that facial identification be utilised as a primary means of identification but only as a supporting indicatory of possible identity. However, when all other avenues have been explored and if the body is badly decomposed or skeletonised then the reconstruction of a face may provide the

intelligence required for a cold case to direct towards potential primary sources of identification. This is the situation illustrated in the case study below.

Case Study

On the 16th October 2011 badly decomposed remains were found by a member of the public in woodlands in East Dunbartonshire, in Scotland. The Procurator Fiscal was content that the circumstances surrounding the death were not suspicious and a one doctor post-mortem examination was performed. Tissue samples were taken for DNA analysis but despite an extensive missing person's check including DNA profiling and examination of the personal effects associated with the remains, no identification was forthcoming. After completion of all possible avenues of investigation the Procurator Fiscal gave permission for burial as an 'unknown' but the investigative authorities requested that a full forensic anthropological assessment be undertaken to see if there was any information that had not been uncovered in the initial examination that subsequently prove to assist with securing an identification.

This case was used as a training exercise for the forensic anthropology team at the University of Dundee and a second post-mortem examination was performed at the Southern General Hospital, on the 30th January 2013 in the presence of the Serious Organised Crime Agency (NPIA) and Strathclyde Police. At the time of publication, this individual remains unidentified.

The first step in the process was to identify the biological profile of the deceased. Sex was determined as being male, evidenced primarily from the morphology of the skull and the pelvis but this also fitted with the clothing recovered. Age was determined to be

adult and most likely in the region of 25-35 years of age. This was determined through assessment of various areas of the skeleton that display age-related characteristics for example the pubic symphysis, the sacrum, the sternum and the clavicles. Ancestry was determined from his facial morphology and was considered to be consistent with Caucasian. The stature of the individual was calculated from the long bones of the upper and lower limbs and calculated to be between 174.5-185.4cm. Therefore in summary, the anthropologists determined that the skeletal remains were that of a young adult male (25-35 years) of average height (5'8"-6'1") and Caucasian ancestry, most likely White.

He had a fracture to his left nasal bone which had fully healed suggesting it had occurred some considerable time before his death. He also sustained a blow to the right side of his jaw. This fractured the bone across the ramus and because he did not seek medical attention for this, the bone did not heal (Figure 1). There was evidence of new bone that had attempted to repair the fracture but in reality it should have been plated by a surgeon. The presence of attempted callous formation indicates that the injury had occurred sometime before death but his lack of medical attention meant that the fracture persisted. He also sustained a fracture to his right lateral pterygoid plate of the sphenoid bone but this was healed. Indeed all three fractures (nasal bone, pterygoid plate and mandible) could have occurred in the same violent incident with two of them healing (nasal and pterygoid) and the third (mandible) being unable to do so because the fracture was in a bone that required to be surgically stabilised. With an unhealed fracture in his mandible, eating solid food would have proved difficult and painful and this situation most likely persisted for quite some time.

His dental hygiene was poor with alveolar resorption, gum disease, abscess cavities and several unfilled decay cavities. At some earlier point in his life he had had quite extensive dental intervention (consistent in style with UK NHS procedures) which consisted of fillings and root canal work. In addition he had a longitudinal fracture to his left upper central incisor with a small chip taken out of the bite surface which could have been linked to the rest of the fracture trauma seen in the skull but may have occurred prior to this.

His upper body showed an asymmetry. His right and left clavicles were of a different size as were his right and left scapulae which showed a marked narrowing in width. This could not be explained and may have no bearing on his identification but may represent some, as yet unknown, clinical condition or syndrome.

The hyoid bone was fractured which was consistent with his suspected cause of death – suicide by hanging.

Hair, nail and bone samples were taken for stable isotope analysis but at the time of writing, these results have not been disclosed.

His clothing consisted of a woollen cardigan, polo shirt, boxer briefs, jeans, ankle socks and trainers (Figure 2). The cardigan was long sleeved and dark blue with a front zip. The brand was MAX which is not common in the UK and is traded in the Middle East. This size was small. The light blue/green polo shirt was from Top Man and was size

small with a distinctive white print covering most of the front. The boxer briefs were not a brand that was readily identified. The jeans are exclusively sold at Officers Club and Petroleum Stores and were a size 30L which was consistent with his anticipated stature and suggests that he was of slim build which would fit with the small size of his polo shirt and cardigan. The hem of the right leg showed greater wear than the hem of the left leg. The ankle socks were unremarkable. The trainers were black with grey and red markings. They carried the label SHOCK X which is a low cost brand sold out of Lidl stores in the UK. His shoe size was UK 11 (EU 45). There was greater wear on the heel of the right than the left shoe and this may be of relevance given the extra wear seen on the right hem of the jeans.

His face was reconstructed using the biological profile determined by the forensic anthropologists, incorporated a hair style that was consistent with the short fair hair identified at the post-mortem and reflected his slim build as identified from his clothing. Also incorporated into the reconstruction was his deviated nose as a result of the nasal fracture (Figure 3).

In summary these remains are considered most likely to be that of a young white adult male (25-35 years) who was between 5ft 8ins and 6ft 1 in height. He had straight, short fair hair. He was slim (clothing was sized as ‘small’) and wore clothes that were consistent with being UK sources from a low to middle price range. He wore size 11 shoes sourced from a low price range store. He had previous dental treatment that was consistent with being undertaken in the UK but had not visited a dentist recently due to presence of quite extensive decay. He had been subject to at least one traumatic episode

that fractured his nose, his sphenoid bone and his mandible. He should have sought medical assistance, but did not or his jaw would have been plated. He must have experienced considerable difficulty eating solid food and may have suffered continuous pain. It is possible that he had a body asymmetry and this may have been evident in his gait.

Despite so much information being available about an individual, including features that are primary identifiers, this case illustrates that if the individual is not listed as missing, then reuniting ante mortem and post mortem information to achieve a positive identification can be extremely challenging. It is therefore extremely important to collect as much information as possible since it cannot be predicted which fact may ultimately aid in the identification of an individual or provide further intelligence that can be followed up by the investigating officer(s).

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Figure 1 – Unhealed fracture to the right mandibular ramus.

Figure 2 – Similar clothing worn by the deceased

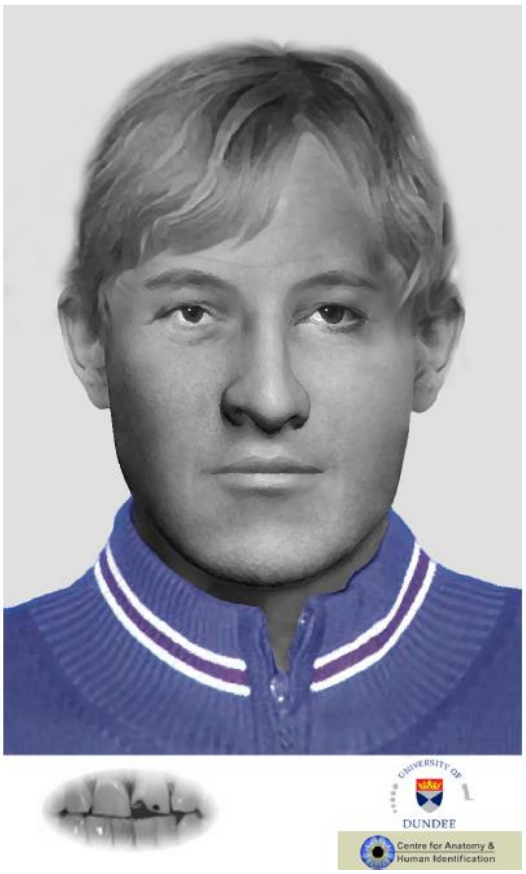

Figure 3 – Facial reconstruction of the deceased. The inset at the bottom shows the damage to his left central incisor.